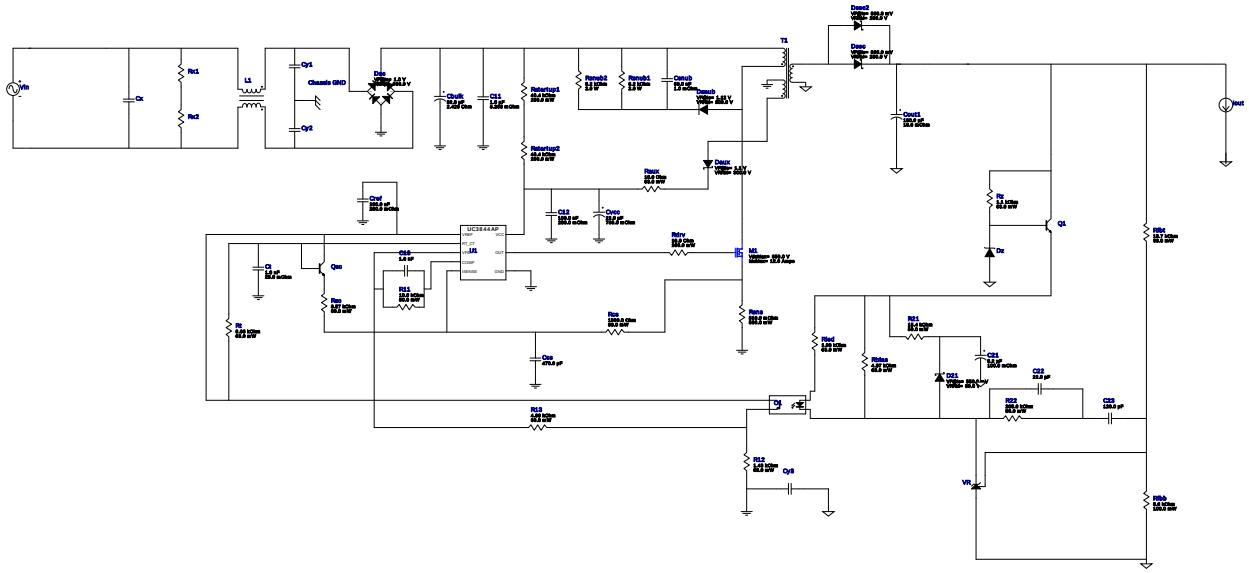
VinMin = 85.0V
VinMax = 265.0V
Vout = 12.0V
Iout = 2.0A

Device = UC3844AN
Topology = Flyback
Created = 2023-02-16 12:48:00.307
BOM Cost = $12.41
BOM Count = 47
Total Pd = 3.18W

WEBENCH® Design Report

Design : 16 UC3844AN
UC3844AN 85V-265V to 12.00V @ 2A



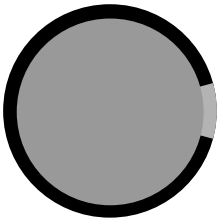
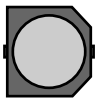
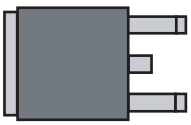
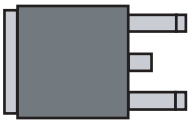
1. The EMI filter shown in the schematic is a placeholder. It has not yet been designed for the application.

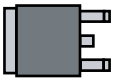
Design Alerts

Component Selection Information
Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin.

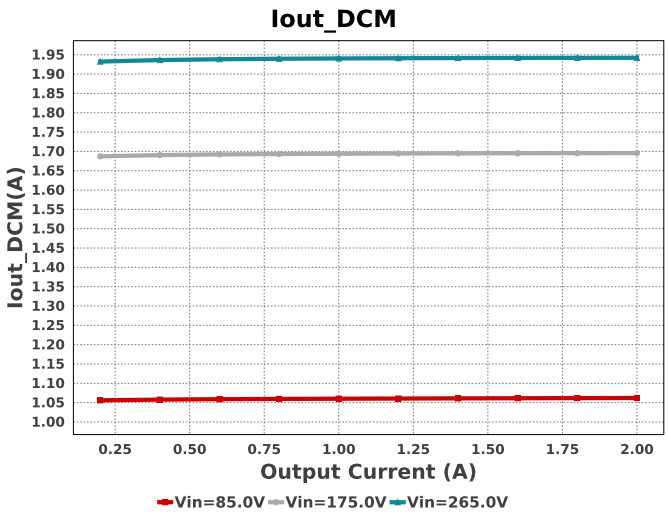
Electrical BOM

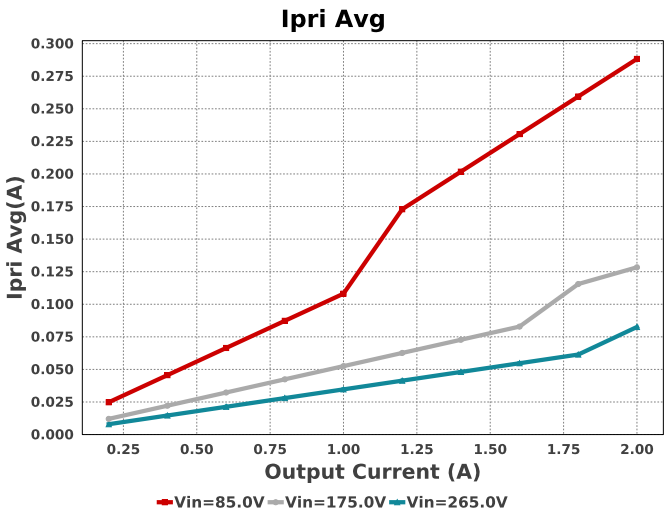
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
C11	TDK	C5750X6S2W105K Series= X6S	Cap= 1.0 uF ESR= 5.263 mOhm VDC= 400.0 V IRMS= 0.0 A	1	$1.25	2220 54 mm^2
C12	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
C13	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
C21	Panasonic	20TQC8R2M Series= TQC	Cap= 8.2 uF ESR= 100.0 mOhm VDC= 20.0 V IRMS= 800.0 mA	1	$0.75	3528-21 17 mm^2
C22	Samsung Electro-Mechanics	CL21C220JBANNNC Series= C0G/NP0	Cap= 22.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
C23	MuRata	GRM0335C1H121JA01D Series= C0G/NP0	Cap= 120.0 pF VDC= 5.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2

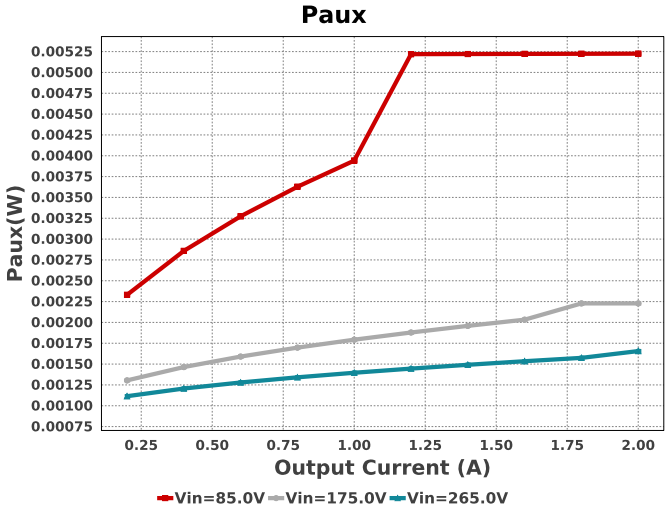
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbulk	Nichicon	LLS2G820MELY Series= 2387	Cap= 82.0 uF ESR= 2.426 Ohm VDC= 400.0 V IRMS= 820.0 mA	1	$1.59	 Nichicon_2000x3000_Snap 484 mm²
Ccs	Samsung Electro-Mechanics	CL21C471JBANNNC Series= C0G/NP0	Cap= 470.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm²
Cout1	Panasonic	25SVPF180M Series= SVPF	Cap= 180.0 uF ESR= 16.0 mOhm VDC= 25.0 V IRMS= 4.65 A	1	$1.17	 CAPSMT_62_E12 106 mm²
Cref	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm²
Csnub	MuRata	GRM43QR72J683KW01L Series= X7R	Cap= 68.0 nF ESR= 1.0 mOhm VDC= 630.0 V IRMS= 0.0 A	1	$0.21	 1812 23 mm²
Ct	Kemet	C0805C102J5GACTU Series= C0G/NP0	Cap= 1.0 nF ESR= 25.0 mOhm VDC= 50.0 V IRMS= 1.71 A	1	$0.02	 0805 7 mm²
Cvcc	Nichicon	UUD1V220MCL1GS Series= uD	Cap= 22.0 uF ESR= 760.0 mOhm VDC= 35.0 V IRMS= 150.0 mA	1	$0.14	 SM_RADIAL_5MM 58 mm²
D21	Panasonic	DB2S31600L	VF@Io= 550.0 mV VRRM= 30.0 V	1	$0.03	 SOD-523 5 mm²
Dac	Diodes Inc.	HD06-T	VF@Io= 1.0 V VRRM= 600.0 V	1	$0.15	 MiniDIP 62 mm²
Daux	SMC Diode Solutions	ST1300ATR	VF@Io= 1.1 V VRRM= 300.0 V	1	$0.12	 SMA 37 mm²
Dsec	ON Semiconductor	MBRB40250TG	VF@Io= 860.0 mV VRRM= 250.0 V	1	$1.11	 DDPAK 210 mm²
Dsec2	ON Semiconductor	MBRB40250TG	VF@Io= 860.0 mV VRRM= 250.0 V	1	$1.11	 DDPAK 210 mm²
Dsnub	Bourns	CD214C-F3600	VF@Io= 1.12 V VRRM= 600.0 V	1	$0.23	 SMC 83 mm²
Dz	ON Semiconductor	BZX84C9V1LT1G	Zener	1	$0.03	 SOT-23 14 mm²

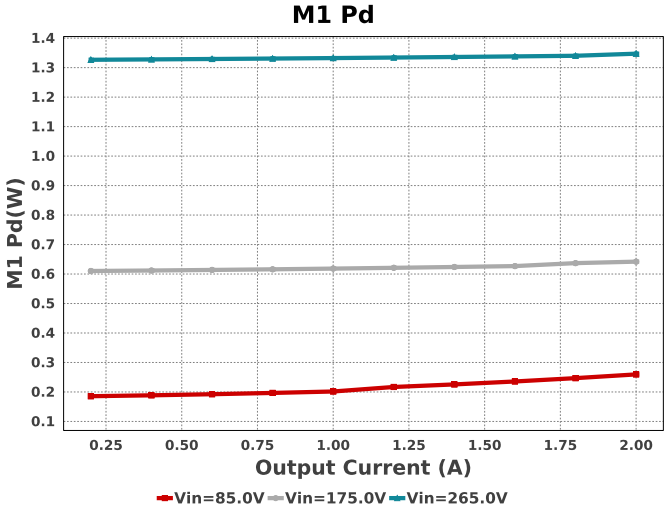
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
M1	STMicroelectronics	STD16N65M5	VdsMax= 650.0 V IdsMax= 12.0 Amps	1	$1.91	 DPAK 102 mm²
O1	Vishay-Semiconductor	TCMT1107	Optocoupler	1	$0.19	 SOP-4 44 mm²
Q1	Diodes Inc.	MMBT3904-7-F	Bipolar Transistor	1	$0.02	 SOT-23 14 mm²
Qsc	STMicroelectronics	2N2222A	Bipolar Transistor	1	$1.19	 TO-18 57 mm²
R11	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm²
R12	Vishay-Dale	CRCW04021K43FKED Series= CRCW..e3	Res= 1.43 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
R13	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
R21	Yageo	RC0201FR-0715K4L Series= ?	Res= 15.4 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm²
R22	Yageo	RC0201FR-07205KL Series= ?	Res= 205.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm²
Raux	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rbias	Vishay-Dale	CRCW04024K87FKED Series= CRCW..e3	Res= 4.87 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rcs	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rdrv	Vishay-Dale	CRCW060310R0FKEA Series= CRCW..e3	Res= 10.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
Rfbb	Yageo	RC0603FR-073K6L Series= ?	Res= 3.6 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
Rfbt	Vishay-Dale	CRCW040213K7FKED Series= CRCW..e3	Res= 13.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rled	Vishay-Dale	CRCW04021K33FKED Series= CRCW..e3	Res= 1.33 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rsc	Vishay-Dale	CRCW04023K57FKED Series= CRCW..e3	Res= 3.57 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rsns	Rohm	MCR25JZHFLR510 Series= MCR25	Res= 510.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.03	 1210 15 mm²
Rsnub1	Vishay-Bccomponents	PR02000208201JR500 Series= ?	Res= 8.2 kOhm Power= 2.0 W Tolerance= 5.0%	1	$0.06	 PR02 117 mm²
Rsnub2	Vishay-Bccomponents	PR02000208201JR500 Series= ?	Res= 8.2 kOhm Power= 2.0 W Tolerance= 5.0%	1	$0.06	 PR02 117 mm²

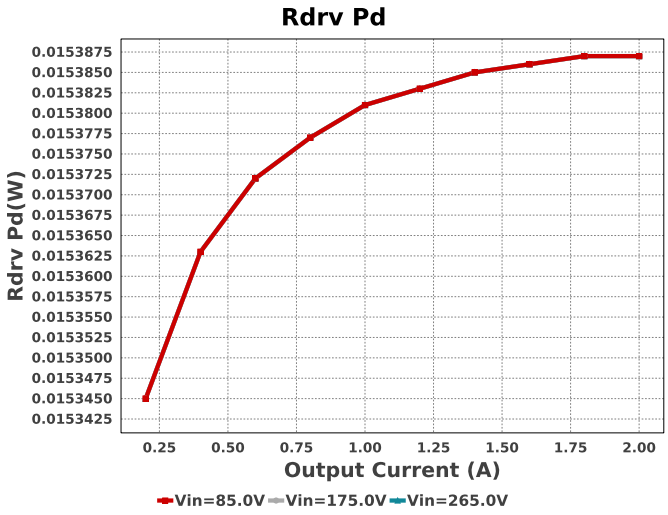
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rstartup1	Vishay-Dale	CRCW120646K4FKEA Series= CRCW..e3	Res= 46.4 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rstartup2	Vishay-Dale	CRCW120646K4FKEA Series= CRCW..e3	Res= 46.4 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rt	Vishay-Dale	CRCW04028K66FKED Series= CRCW..e3	Res= 8.66 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rz	Vishay-Dale	CRCW04021K10FKED Series= CRCW..e3	Res= 1.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
T1	Core=TDK , CoilFormer=TDK	Core=B66317G0000X187 , CoilFormer=B66208X1110T001	Lp= 339.0 µH Turns Ratio(Nas)= 15:12 Turns Ratio(Nps)= 43:12 Npri= 43.0 Naux= 15.0 Nsec= 12.0	1	$0.30	TDK_B66305 569 mm²
U1	Texas Instruments	UC3844AN	Switcher	1	$0.43	P0008A 116 mm²
VR	Texas Instruments	TL431IDBVR	Voltage References	1	$0.09	R-PDSO-G3 16 mm²

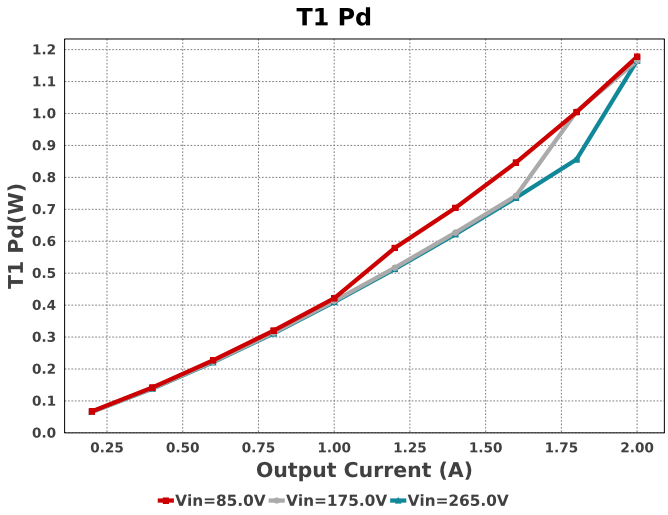


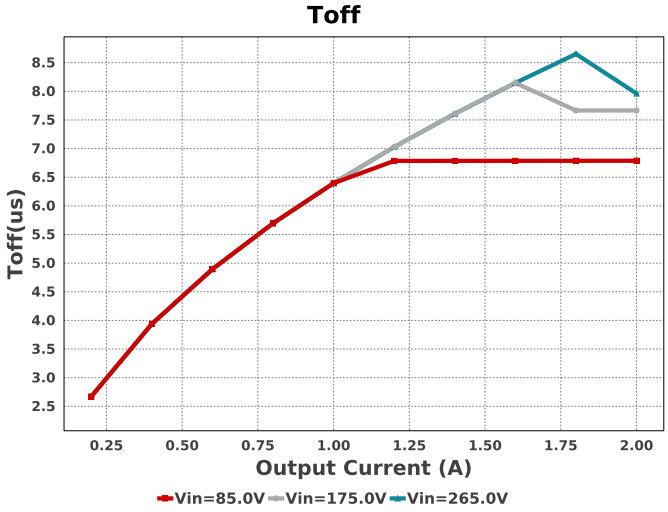


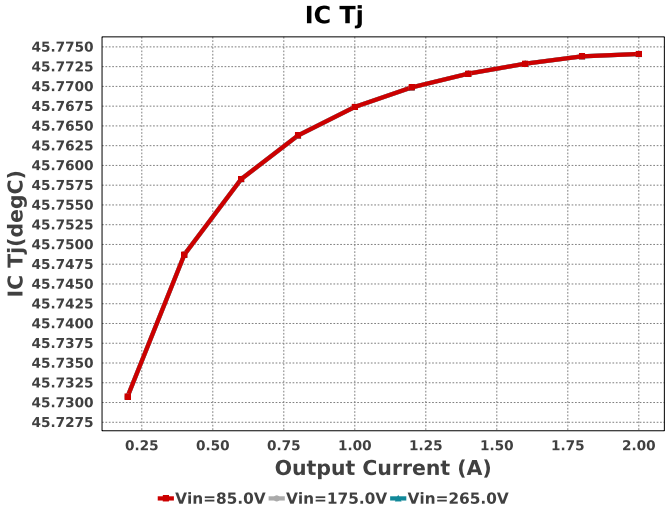


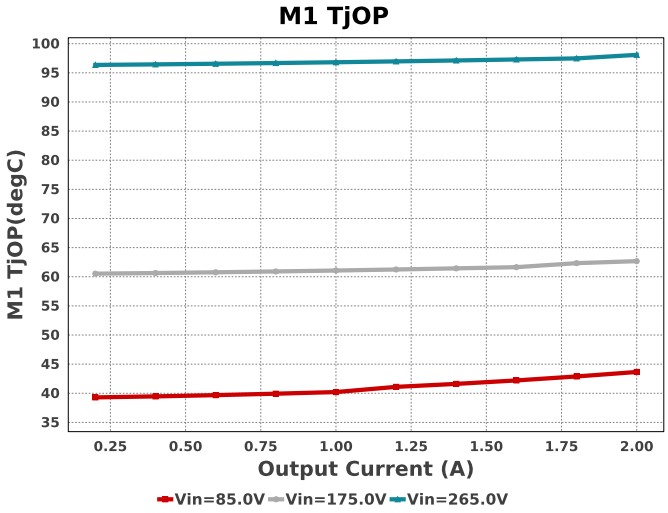


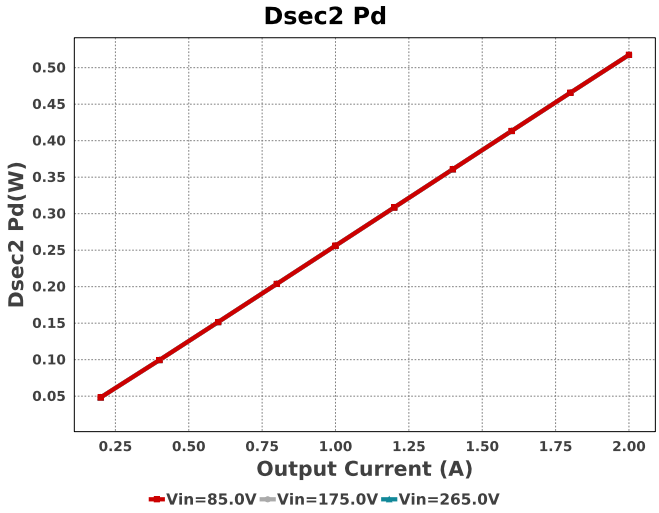




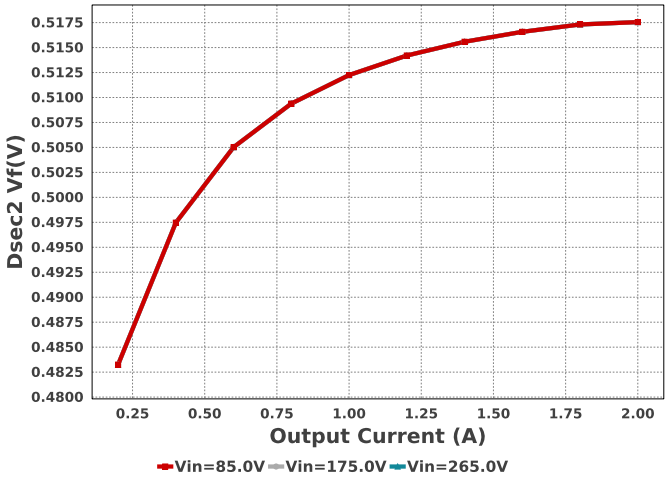




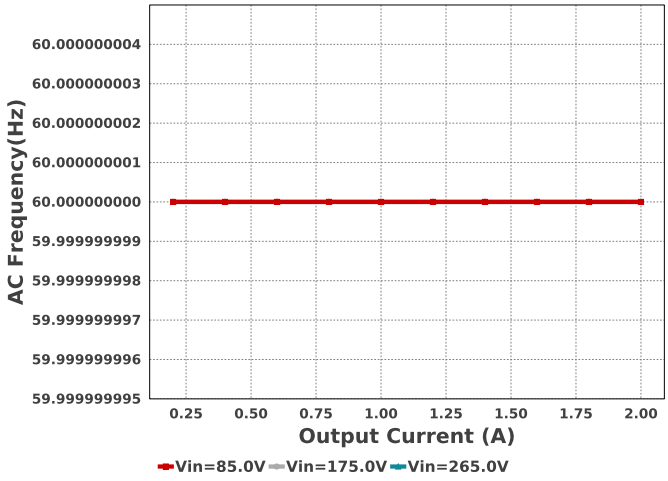




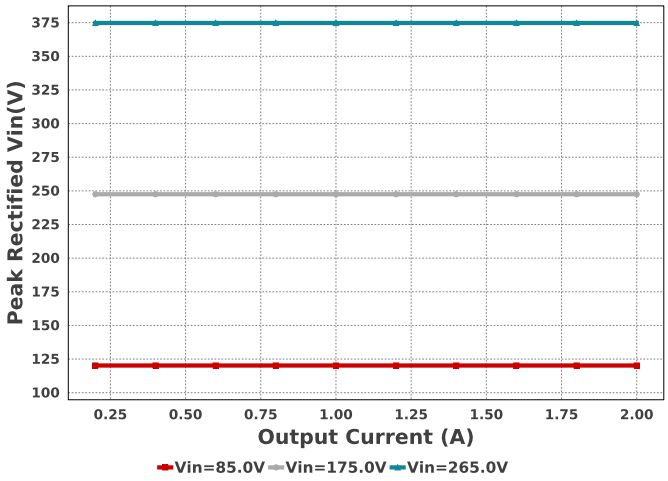
Dsec2 Vf



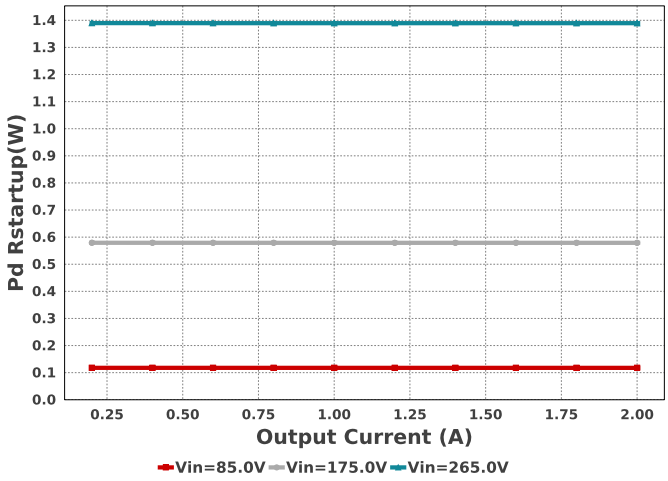
AC Frequency



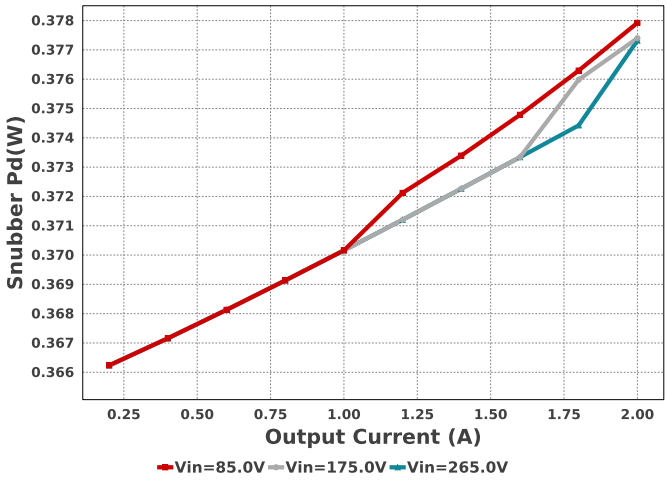
Peak Rectified Vin



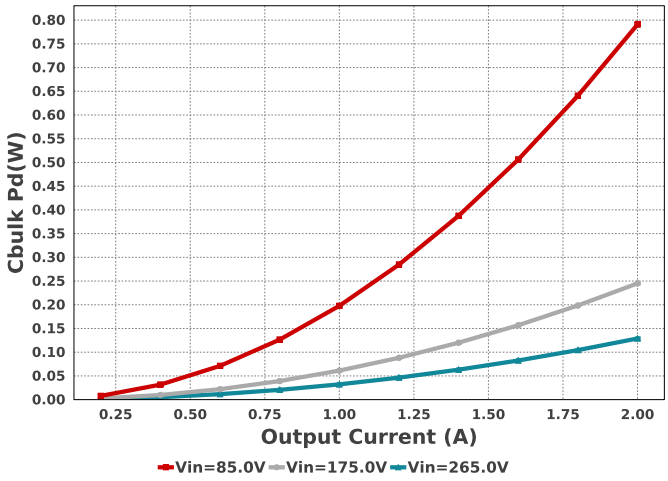
Pd Rstartup

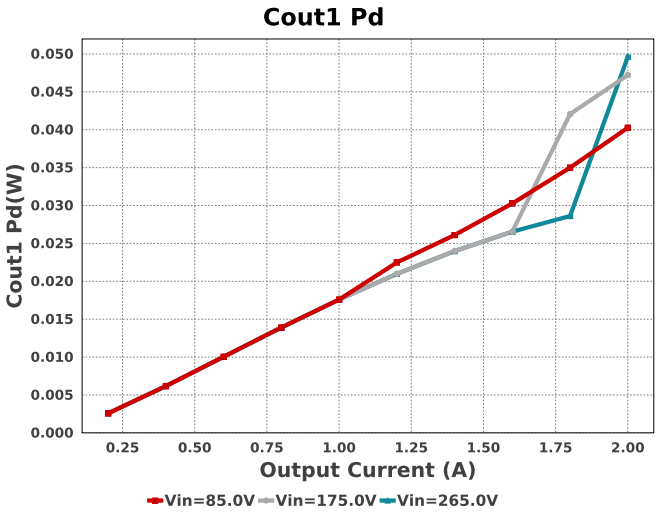


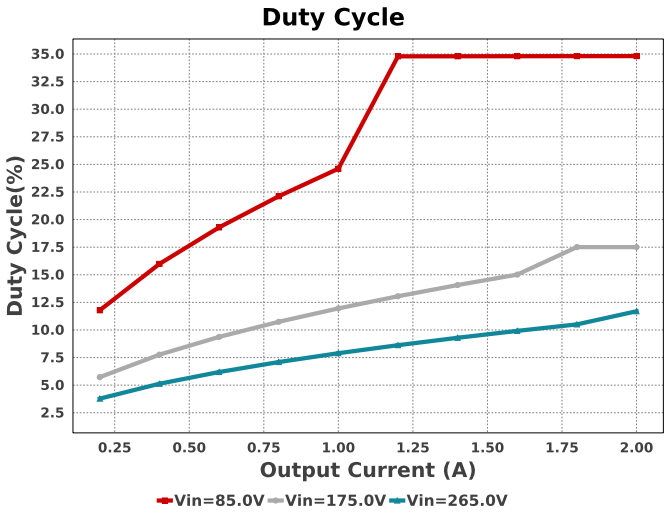
Snubber Pd

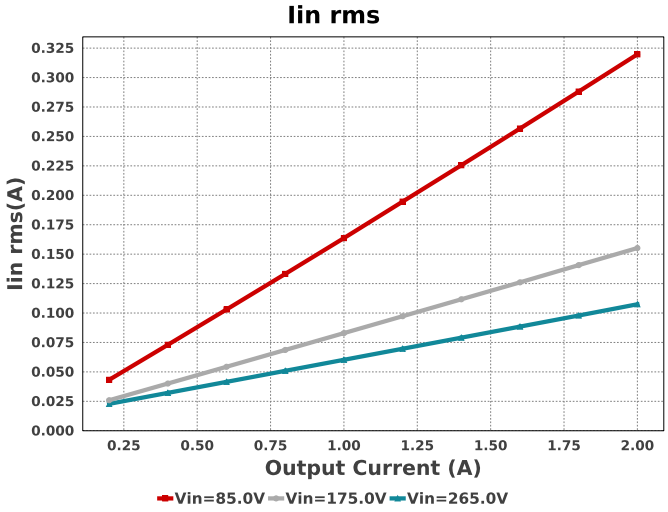


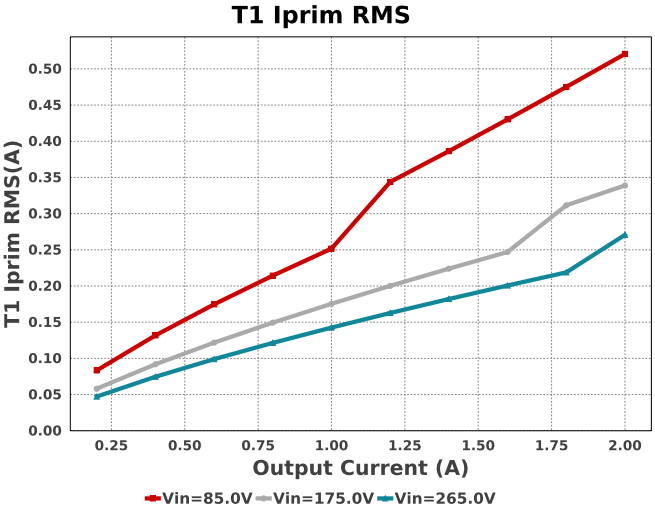
Cbulk Pd

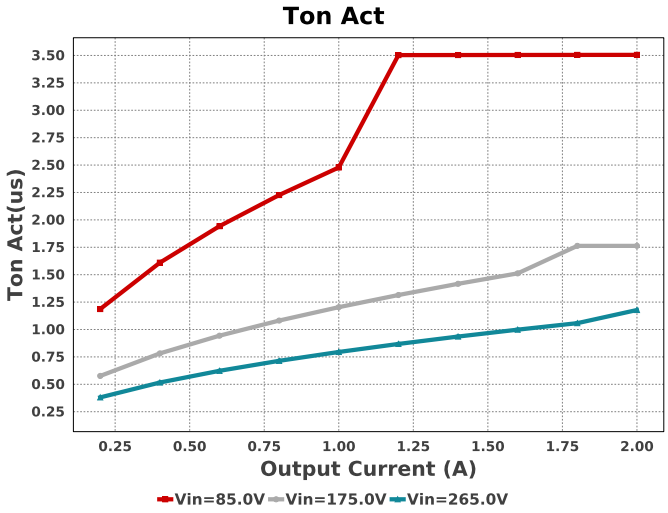


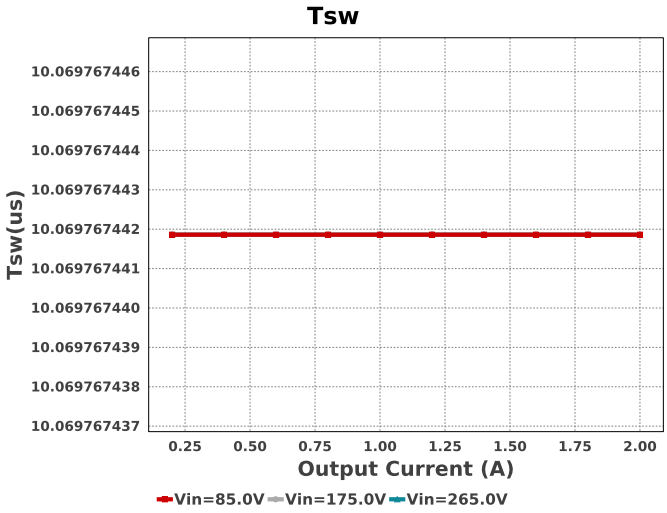


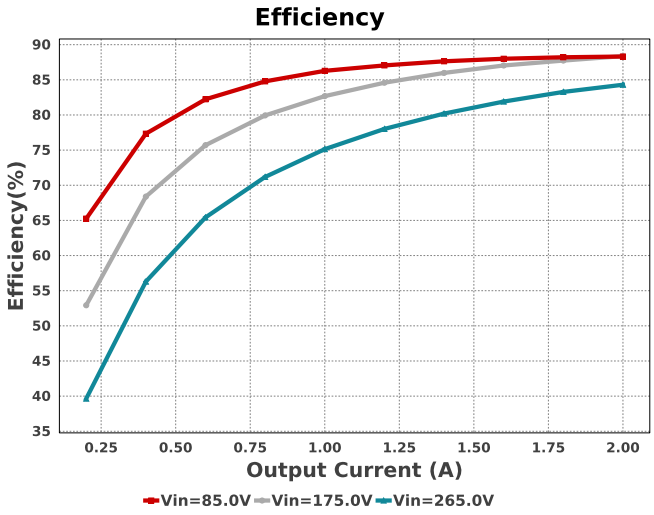


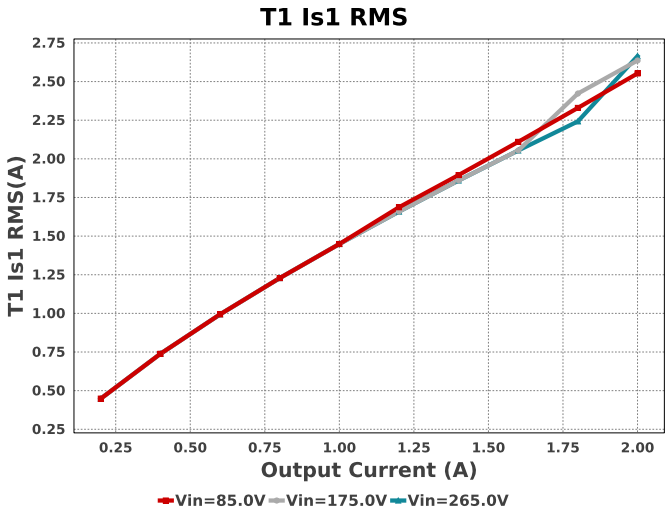


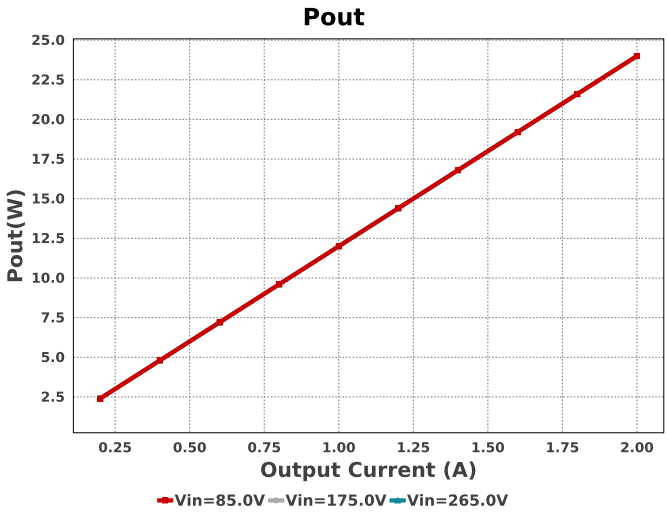


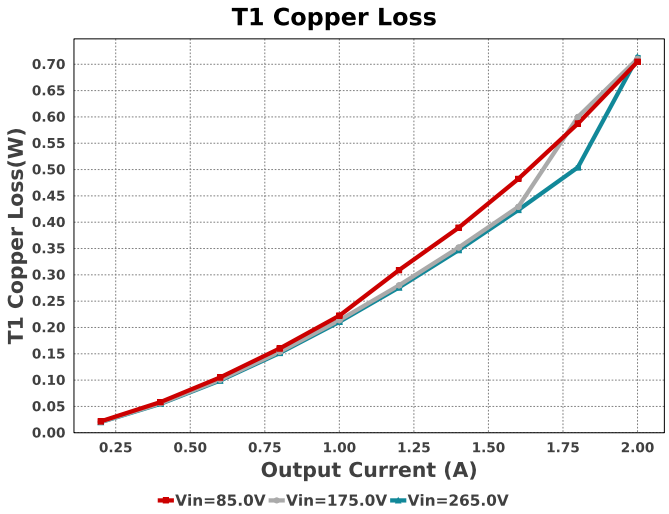


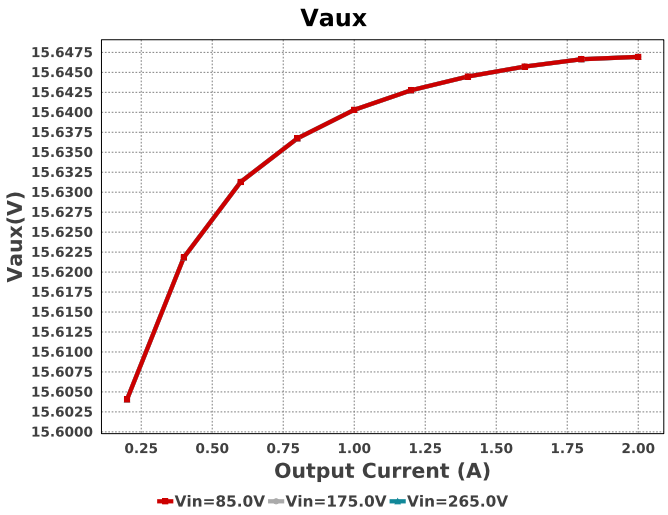


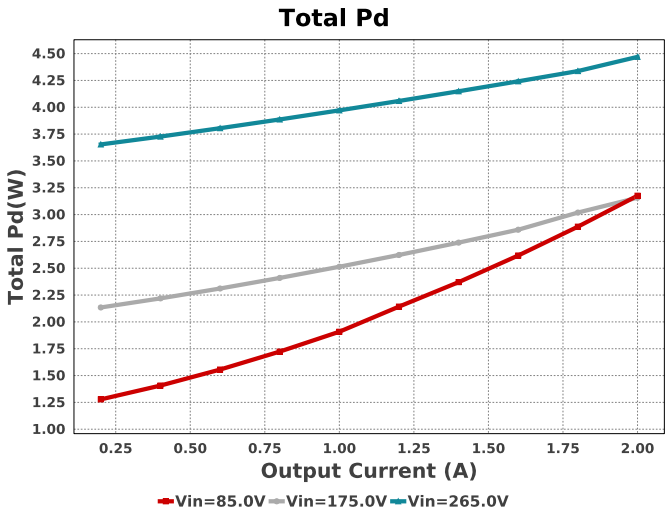


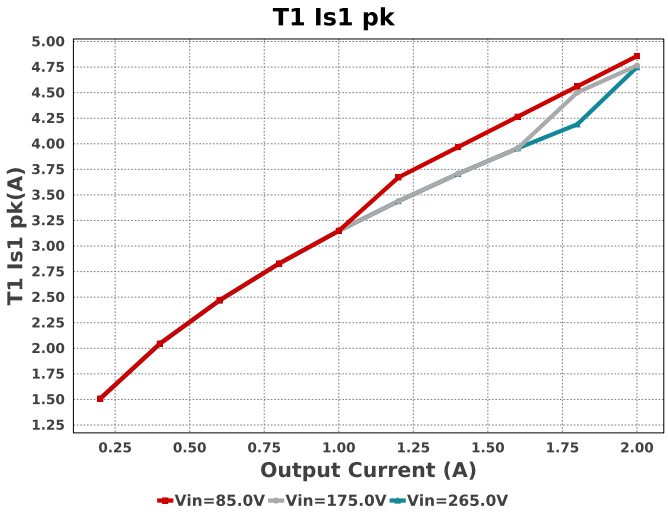


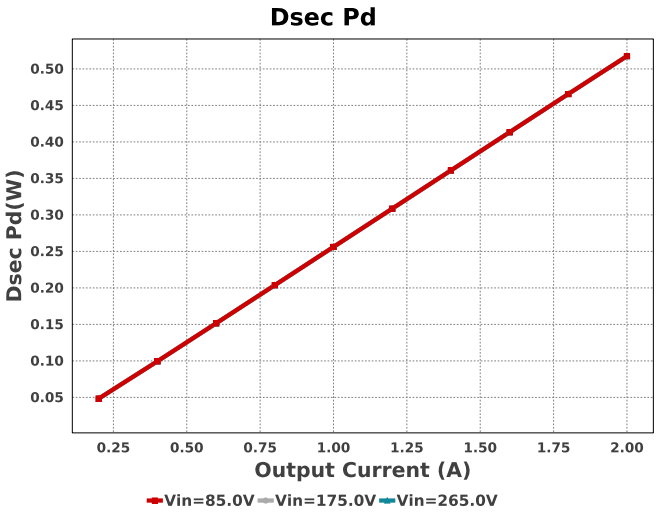


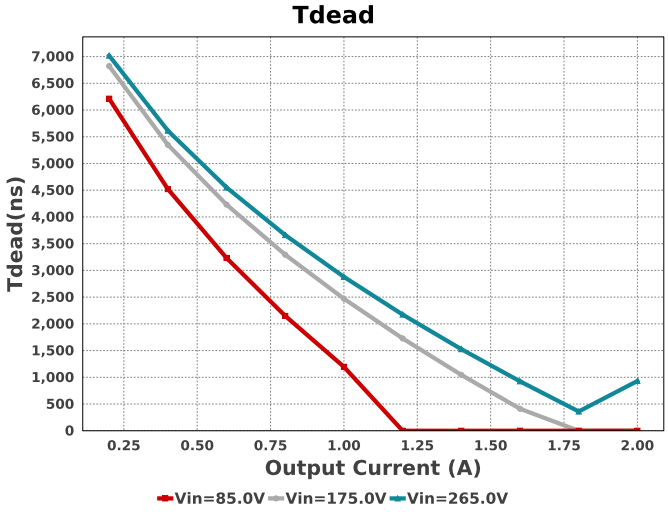


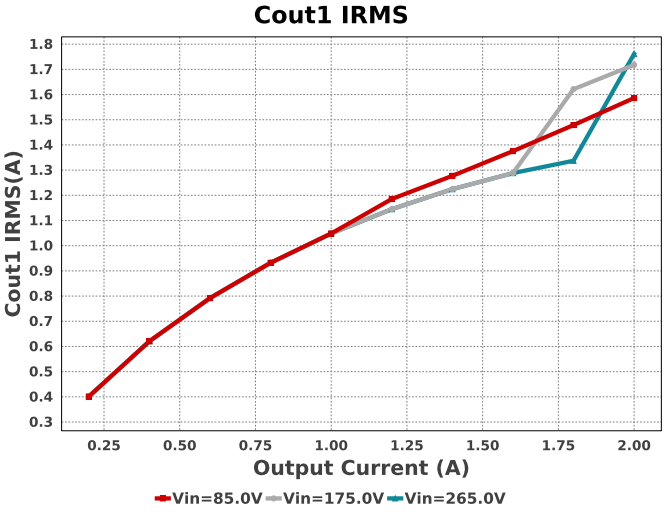


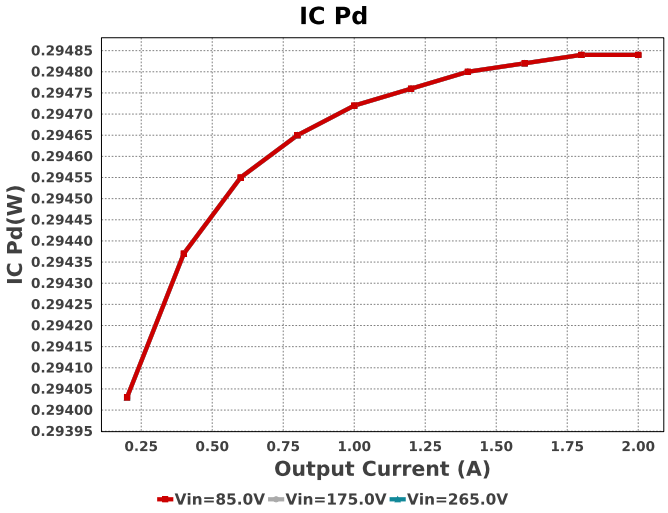


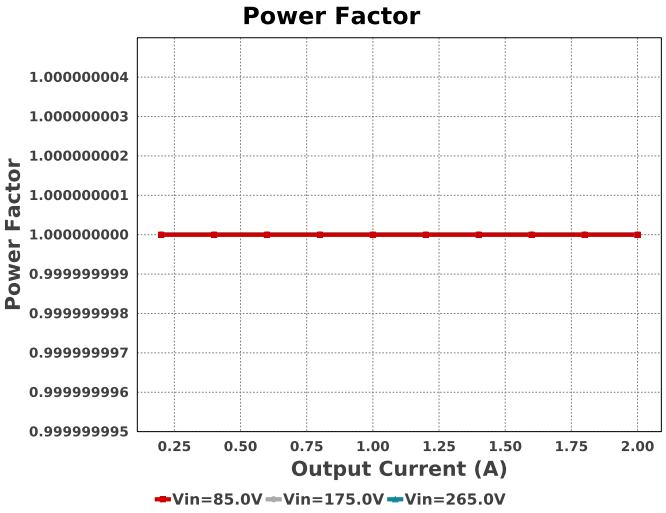


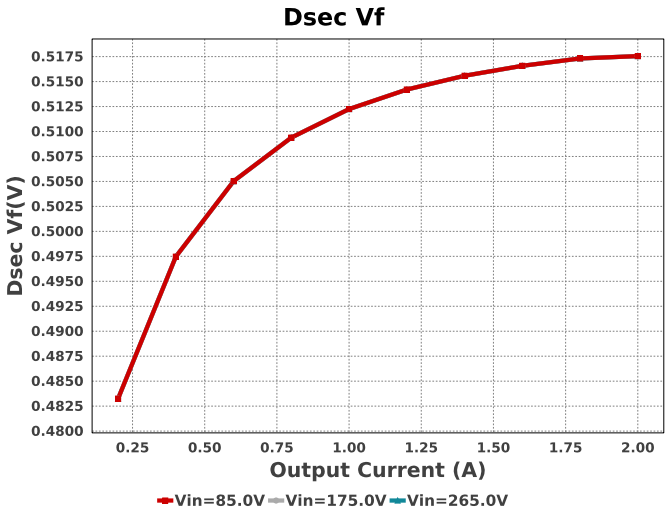


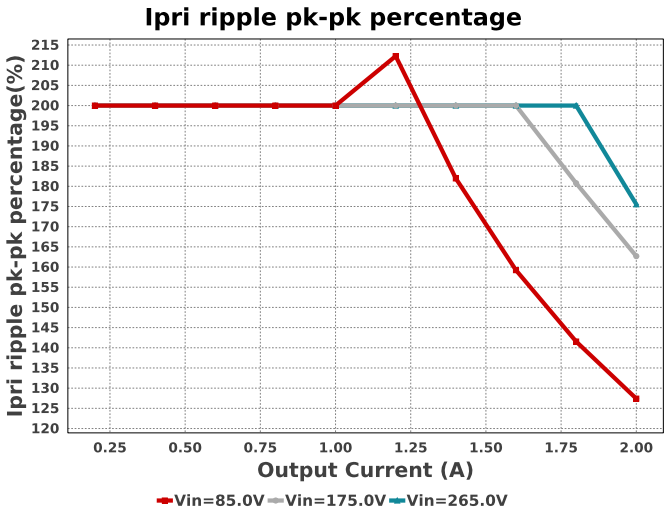


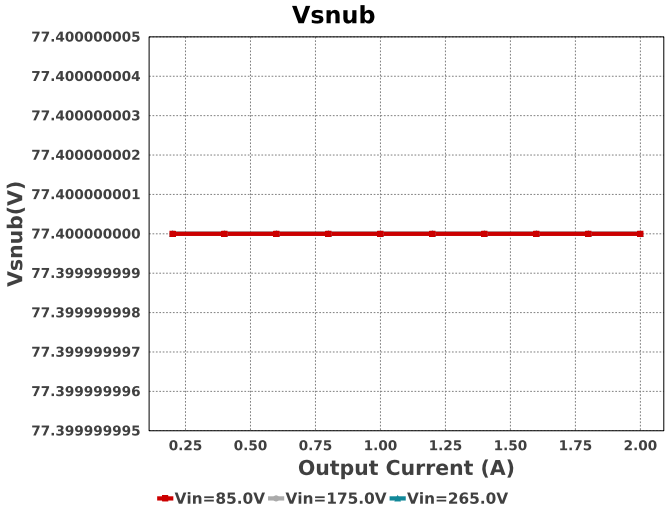


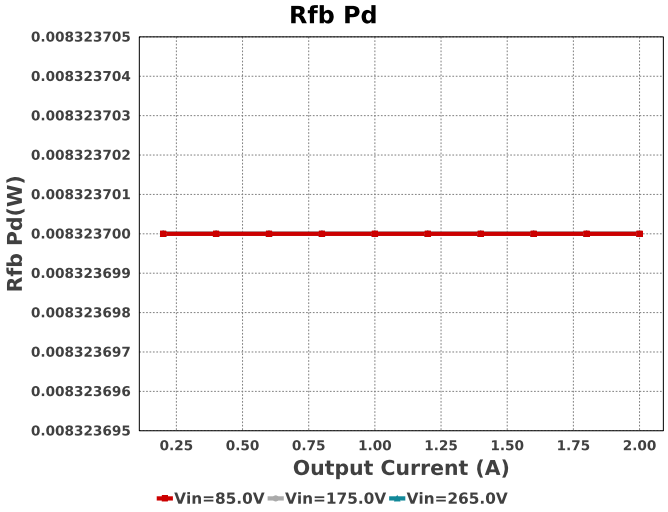


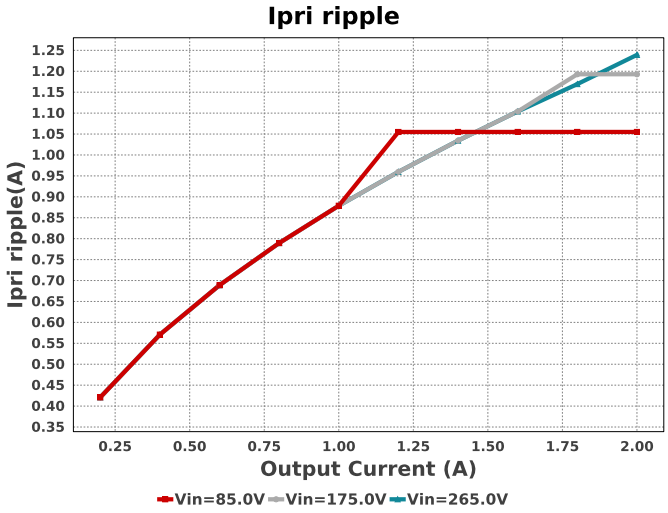


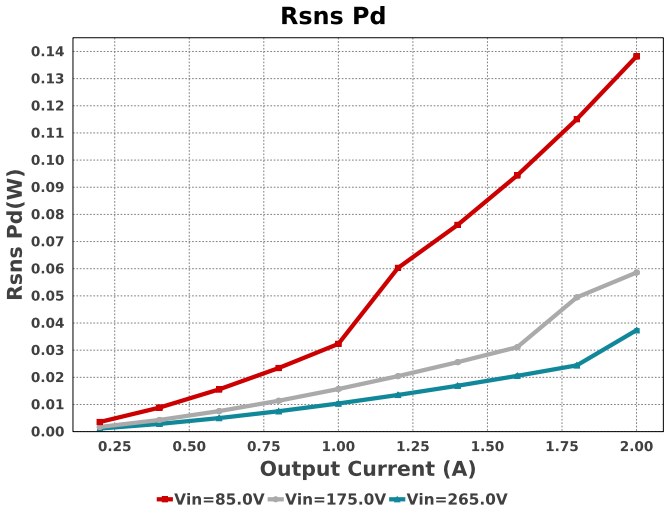


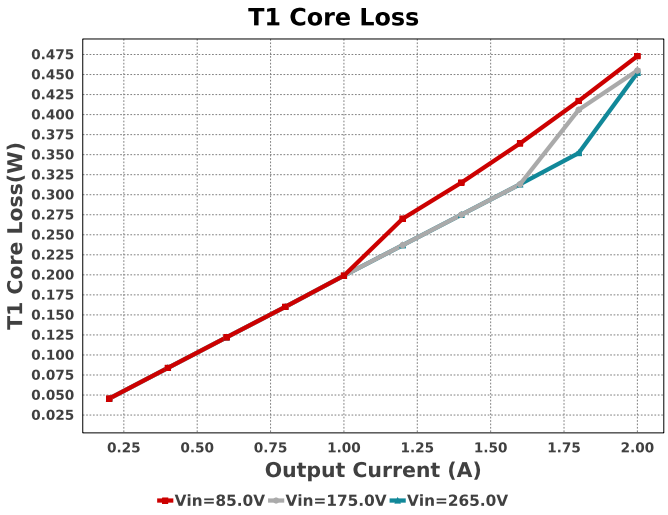


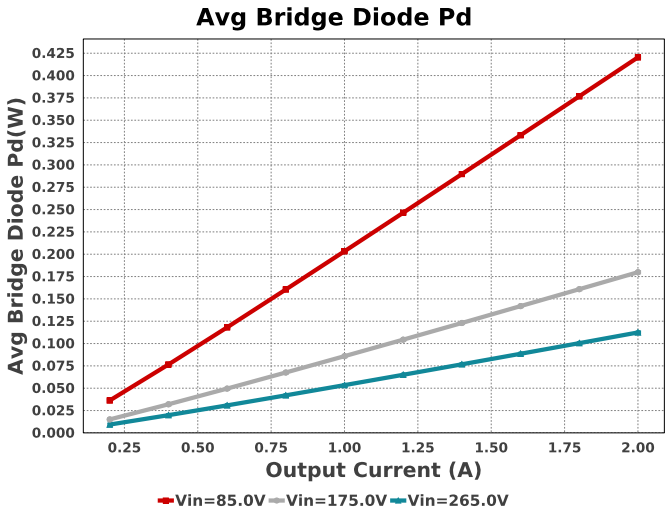


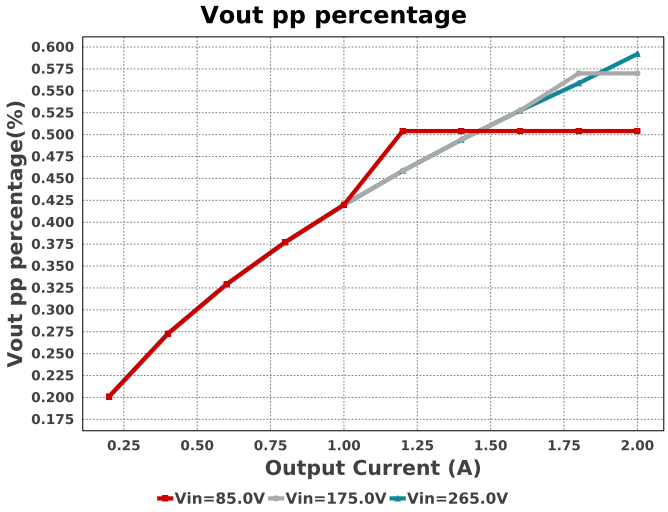


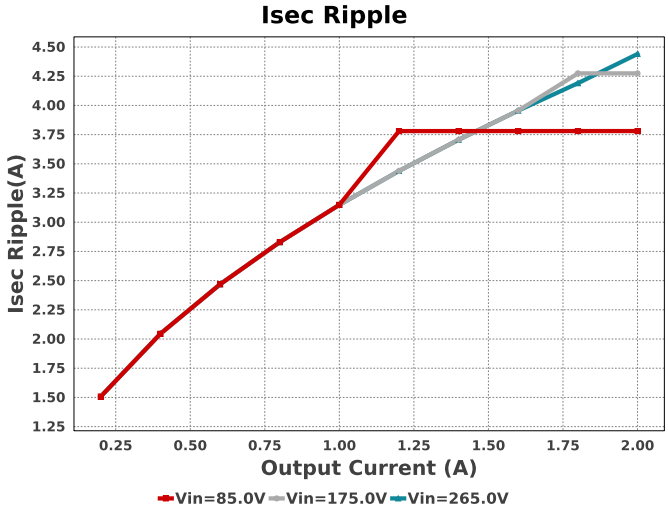


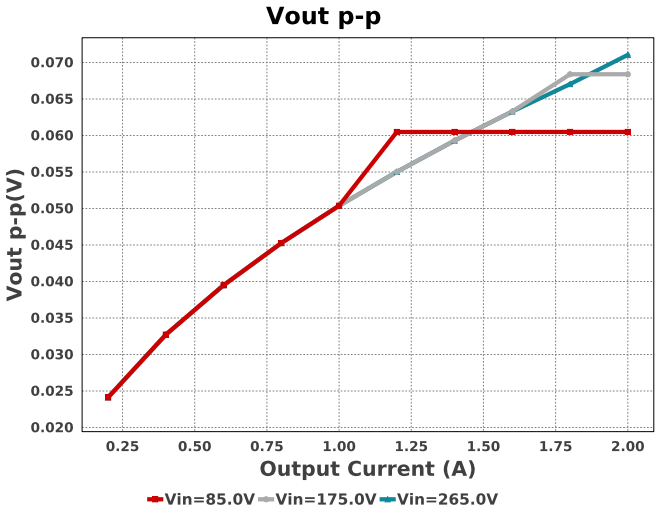


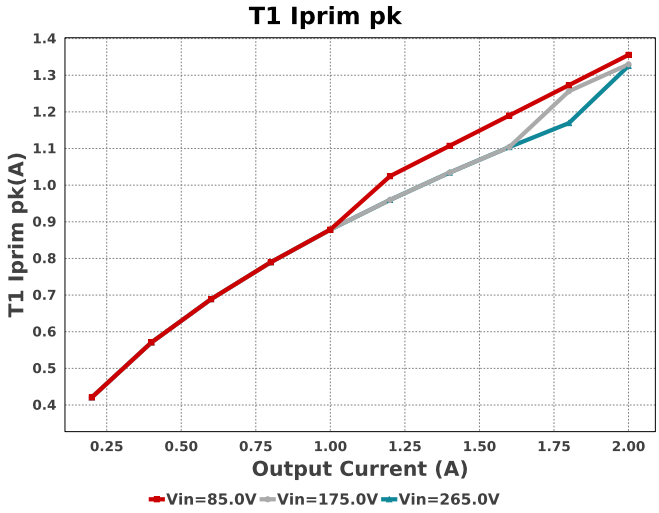












Operating Values

#	Name	Value	Category	Description
1.	Cbulk Pd	790.85 mW	Capacitor	Bulk capacitor power dissipation
2.	Cout1 IRMS	1.586 A	Capacitor	Output capacitor1 RMS ripple current
3.	Cout1 Pd	40.257 mW	Capacitor	Output capacitor1 power dissipation
4.	Avg Bridge Diode Pd	420.4 mW	Diode	Average Power Dissipation in the Bridge Diode over the AC Line Period
5.	Daux trr	35.0 ns	Diode	Auxiliary Diode Reverse Recovery Time
6.	Dsec Pd	517.55 mW	Diode	Secondary Diode Power Dissipation
7.	Dsec Vf	517.55 mV	Diode	Effective Forward Voltage Drop at the Operating Current
8.	Dsec trr	0.0 ns	Diode	Output Diode Reverse Recovery Time
9.	Dsec2 Pd	517.55 mW	Diode	Secondary Diode Power Dissipation
10.	Dsec2 Vf	517.55 mV	Diode	Effective Forward Voltage Drop at the Operating Current
11.	Dsnub trr	30.0 ns	Diode	Snubber Diode Reverse Recovery Time

#	Name	Value	Category	Description
12.	IC Pd	294.84 mW	IC	IC power dissipation
13.	IC Tj	45.774 degC	IC	IC junction temperature
14.	ICThetaJA	53.5 degC/W	IC	IC junction-to-ambient thermal resistance
15.	M1 Pd	259.56 mW	Mosfet	M1 MOSFET total power dissipation
16.	M1 TjOP	43.655 degC	Mosfet	M1 MOSFET junction temperature
17.	Avg Bridge Diode Pd	420.4 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
18.	Cbulk Pd	790.85 mW	Power	Bulk capacitor power dissipation
19.	Cout1 Pd	40.257 mW	Power	Output capacitor1 power dissipation
20.	Dsec Pd	517.55 mW	Power	Secondary Diode Power Dissipation
21.	Dsec2 Pd	517.55 mW	Power	Secondary Diode Power Dissipation
22.	IC Pd	294.84 mW	Power	IC power dissipation
23.	M1 Pd	259.56 mW	Power	M1 MOSFET total power dissipation
24.	Paux	5.225 mW	Power	Power Dissipation in Raux and Daux
25.	Pd Rstartup	117.71 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
26.	Rdrv Pd	15.387 mW	Power	Power Dissipation in Gate Drive Resistor
27.	Rfb Pd	8.324 mW	Power	Rfb Power Dissipation
28.	Rsns Pd	138.2 mW	Power	Current Limit Sense Resistor Power Dissipation
29.	Snubber Pd	377.922 mW	Power	Snubber Power Dissipation
30.	T1 Copper Loss	596.7 mW	Power	Transformer Copper Loss Power Dissipation
31.	T1 Core Loss	444.0 mW	Power	Transformer Core Loss Power Dissipation
32.	T1 Pd	1.041 W	Power	Estimated Losses in Transformer
33.	Total Pd	3.176 W	Power	Total Power Dissipation
34.	Pd Rstartup	117.71 mW	Resistor	Power Dissipation in Rstartup1 and Rstartup2
35.	Rdrv Pd	15.387 mW	Resistor	Power Dissipation in Gate Drive Resistor
36.	Rfb Pd	8.324 mW	Resistor	Rfb Power Dissipation
37.	Rsns Pd	138.2 mW	Resistor	Current Limit Sense Resistor Power Dissipation
38.	AC Frequency	60.0 Hz	System Information	Input AC frequency
39.	BOM Count	47	System Information	Total Design BOM count
40.	Duty Cycle	34.811 %	System Information	Duty cycle
41.	Efficiency	88.314 %	System Information	Steady state efficiency
42.	FootPrint	2.636 k mm^2	System Information	Total Foot Print Area of BOM components
43.	Frequency	99.307 kHz	System Information	Switching frequency
44.	Iin rms	319.72 mA	System Information	RMS Input Current
45.	Iout	2.0 A	System Information	Iout operating point
46.	Iout_DCM	1.062 A	System Information	Approximate Current below which DCM mode of operation will begin
47.	Mode	CCM	System Information	Conduction Mode
48.	Peak Rectified Vin	120.207 V	System Information	Peak voltage seen at rectified input
49.	Pout	24.0 W	System Information	Total output power
50.	Power Factor	1.0	System Information	Assumed Power Factor for the Application
51.	Tdead	0.0 ns	System Information	Approximate Dead Time of the Regulator
52.	Toff	6.787 us	System Information	Approximate Converter Off Time
53.	Ton Act	3.505 us	System Information	Approximate Converter On Time
54.	Total BOM	$12.41	System Information	Total BOM Cost
55.	Tsw	10.07 us	System Information	Switching Time Period
56.	Vin_RMS	85.0 V	System Information	Vin operating point
57.	Vout	12.0 V	System Information	Operational Output Voltage
58.	Vout Actual	11.99 V	System Information	Vout Actual calculated based on selected voltage divider resistors
59.	Vout Tolerance	1.926 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
60.	Vout p-p	60.487 mV	System Information	Peak-to-peak output ripple voltage
61.	Vout pp percentage	504.061 m%	System Information	Output Voltage ripple percentage
62.	Vsnub	77.4 V	System Information	Voltage Across the Snubber

#	Name	Value	Category	Description
63.	Ipri Avg	288.258 mA	Transformer	Average Current in Primary Winding over the complete Switching Period
64.	Ipri ripple	1.055 A	Transformer	Ripple Current in the Primary Winding
65.	Ipri ripple pk-pk percentage	127.406 %	Transformer	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
66.	Isec Ripple	3.78 A	Transformer	Ripple Current in the Secondary Winding
67.	Paux	5.225 mW	Transformer	Power Dissipation in Raux and Daux
68.	T1 Copper Loss	596.7 mW	Transformer	Transformer Copper Loss Power Dissipation
69.	T1 Core Loss	444.0 mW	Transformer	Transformer Core Loss Power Dissipation
70.	T1 Iprim RMS	520.564 mA	Transformer	Transformer Primary RMS Current
71.	T1 Iprim pk	1.356 A	Transformer	Transformer Primary Peak Current
72.	T1 Is1 RMS	2.553 A	Transformer	Transformer Secondary1 RMS Current
73.	T1 Is1 pk	4.857 A	Transformer	Transformer Secondary1 Peak Current
74.	T1 Pd	1.041 W	Transformer	Estimated Losses in Transformer
75.	Vaux	15.647 V	Transformer	Auxiliary Voltage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	265.0	Maximum input voltage
VinMin	85.0	Minimum input voltage
Vout	12.0	Output Voltage
acFrequency	60.0	AC Frequency
base_pn	UC3844A	Base Product Number
source	AC	Input Source Type
Ta	30.0	Ambient temperature

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

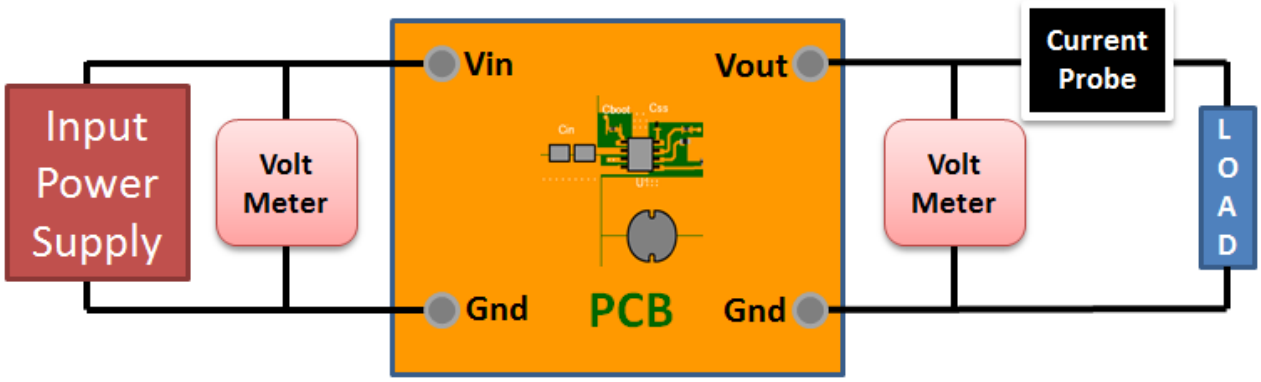
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 85.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



WEBENCH® Transformer Report

#	Name	Value
1.	Core Part Number	B66317G0000X187
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B66208X1110T001
4.	Coil Former Manufacturer	TDK

Transformer Electrical Diagram

Primary

Turns	43.0
AWG	27.0
Layers	4.0
Strands	3.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	12.0
AWG	30.0
Layers	1.0
Strands	2.0
Insulation Type	Triple Insulated

Auxiliary

Turns	15.0
AWG	28.0
Layers	1.0
Strands	2.0
Insulation Type	Heavy Insulated Magnet Wire

Transformer Construction Diagram

Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 2/4.0	27.0	22	Clockwise
Auxiliary	28.0	15.0	Counter Clockwise
Triple Insulated Secondary	30.0	12.0	Counter Clockwise
Primary Second 2/4.0	27.0	21	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	3.39E-4H
2.	Inductance Factor(Al)	184.0nH
3.	Npri	43.0
4.	Nsec	12.0
5.	Naux	15.0
6.	Core Type	E25/13/7
7.	Core Material	N87

#	Name	Value
8.	Bmax	0.20T
9.	Switching Frequency	99.31kHz
10.	DMax	0.36
11.	Ipk(Primary)	1.31A
12.	Irms(Primary)	0.5A
13.	Ipk(Secondary)	4.71A
14.	Irms(Secondary)	2.38A

Design Assistance

1. Master key : 5601E6D956368EA766F626A92E56EDD0[v1]
2. **UC3844A** Product Folder : http://www.ti.com/product/UC3844A : contains the data sheet and other resources.